

DELAWARE CONSTRUCTION SPECIFICATION

CONCRETE CS 31

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated on the drawings.

2. MATERIALS, PROPORTIONING, MIXING AND DELIVERY

The concrete shall be delivered to the forms in accordance with the provisions of ASTM Specification C-94 and as further specified in Section 15 of this specification.

3. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a non-staining form oil before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts, or other devices that permit their removal to a depth of at least 1 inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

4. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by wire brush scrubbing and shall be wetted immediately prior to the placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth or uncompacted fill or frozen subgrade will not be permitted.

Unless otherwise specified, when concrete is to be placed over drain fill, the contact surface of the drain fill shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete. Forms for weepholes shall extend through this layer into the drain fill.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

5. **PLACING**

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved by the NRCS Technician. Reasonable notice shall be given to the NRCS Technician prior to the time of concrete placement. Such notice shall be far enough in advance to give the Technician adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with the specifications before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance.

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used when vertical drop is in excess of 5 feet.

Immediately after the concrete is placed in the forms, it shall be consolidated by spading, hand tamping or vibration as necessary to insure smooth surfaces and dense concrete. Each layer shall be consolidated to insure monolithic bond with the preceding layer. If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when spaded or vibrated, the placement of concrete will be discontinued and a construction joint will be made.

If placing is discontinued when an incomplete horizontal layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

6. **CONSTRUCTION JOINTS**

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations and in a manner approved by the NRCS Technician.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns, as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the technician. The surfaces shall be kept moist for at least 1 hour prior to placement of the new concrete.

7. **EXPANSION AND CONTRACTION JOINTS**

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

Performed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

When open joints are specified, they shall be constructed by the insertion and subsequent removal of a wooden strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be

chipped or broken. The edges of open joints shall be finished with an edging tool prior to removal of the joint strips.

8. **WATERSTOPS**

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be soldered, brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

9. **REMOVAL OF FORMS**

Forms shall not be removed before the expiration of the following minimum time intervals after placement of concrete.

<u>Item</u>	<u>Time</u>
Beam bottom forms and temporary supports	14 days
Roof or deck slabs	14 days
Columns	7 days
Bearing walls	7 days
Nonbearing walls	24 hours
Sides of beams	24 hours

Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

10. **FINISHING FORMED SURFACES**

Immediately after the removal of the forms:

- a. All fins and irregular projections shall be removed from exposed surfaces.
- b. On all surfaces, the holes produced by the removal of form ties, cone-bolts, and she-bolts shall be cleaned, wetted and filled with dry-pack mortar consisting of one part portland cement, three parts sand that will pass a No. 16 sieve, and water just sufficient to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed.

11. **FINISHING UNFORMED SURFACES**

All exposed surfaces of the concrete shall be accurately screeded to grade and then wood float finished.

Excessive floating or troweling of surface while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

12. **CURING**

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period, or until curing compound is applied as specified below.

Moisture shall be maintained by sprinkling, flooding or spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Concrete, except at construction joints, may be coated with an approved curing compound in lieu of continued application of moisture.

The compound shall be sprayed on the moist concrete surfaces as soon as free water has disappeared, but shall not be applied to any surface until patching, repairs and finishing of that surface are completed. The compound shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface and shall form a continuous adherent membrane over the entire surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items. If the membrane is damaged during the curing period, the damaged area shall be resprayed at the rate of application specified above.

13. **REMOVAL OR REPAIR**

Concrete that is honeycombed, damaged or otherwise defective shall be removed and the structure or structural member replaced, or where feasible, the defective parts repaired. The NRCS Technician will determine the

required extent of removal, replacement or repair. The plan for effecting the repair must be approved by the Technician prior to beginning of repair work.

14. **CONCRETING IN COLD WEATHER**

Concrete shall not be mixed nor placed when the daily minimum atmospheric temperature is less than 40°F. unless facilities are provided to prevent the concrete from freezing. The use of accelerators or antifreeze compounds will not be allowed. The temperature of the concrete at the time of placing shall not be less than 50°F. and shall be maintained at temperatures not less than 40°F. for the duration of the curing period.

15. **CONCRETING IN HOT WEATHER**

The supplier shall apply effective means to maintain the temperature of the concrete below 90°F. during mixing and conveying. Exposed surfaces shall be continuously moistened by means of fog sprays or otherwise protected from drying during the time between placement and finishing and after finishing. Finishing of slabs and exposed surfaces shall commence as soon as the condition of the concrete allows and be completed without delay.

16. **QUALITY OF CONCRETE**

- a. **Class of Concrete** - The supplier shall be responsible for the design of the concrete mix and for certification by tests that the compressive strength at 28 days is equal to or greater than 3000 psi.

The mix shall not contain less than 6 sacks of cement per cubic yard.

The net water content shall not exceed 7 gallons of water per sack of cement.

- b. **Materials**

Cement shall be Type I or IA.

Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. Certain manufactured sands produce slippery surfaces and should be investigated for acceptance before use. (ASTM C-33).

Fine aggregate, except as provided in Section 4.2 (ASTM C-33) shall be graded within the following limits:

<u>Sieve Designation</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

Coarse aggregate shall be size numbers 467, 57, or 67 (ASTC C-33).

Calcium chloride or other corrosive accelerators shall not be used, unless otherwise specified.

Fly ash may be used as a partial substitution for portland cement in an amount not greater than 25 percent (by weight) of cement in the concrete mix, unless otherwise specified.

Ground granulated blast-furnace slag may be used as a partial substitution for portland cement in amounts between 25 to 70 percent (by weight) of cement in the concrete mix, unless otherwise specified.

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D-994 or ASTM Specification D-1752, Type I, Type II, or Type III.

- c. **Air Content and Consistency** - Air entrainment shall range from 5 to 7 percent.

The slump range shall be from 3 to 5 inches.

- b. Concrete shall be delivered to the site and discharged within 1-1/2 hours after the introduction of the cement to the aggregates. This time may be extended if the slump remains within specified limits without the addition

of water to the batch. When the temperature of the concrete is 85°F. or above, the time between introduction of the cement to the aggregates and discharge shall not exceed 45 minutes unless a set retarder is used in the mix.

17. **SUPERPLASTICIZED CONCRETE**

Superplasticized concrete shall be a concrete mix containing either a water-reducing, high-range admixture (ASTM C-494 type F or G) at a dosage rate that reduces the quantity of water required to produce a concrete mix within the slump range, or a plasticizing admixture (ASTM C-1017) at the dosage rate required to produce an increase in the slump of at least 2 inches more than that specified in section 16 c. of this specification.

The plasticizing admixture shall be introduced into the concrete as specified by the manufacturer and shall be compatible with other admixtures in the concrete mix.

The amount of water in the concrete mix shall be equal to or less than the amount of water added to the mix for the specified strength class of concrete.

The cement content of the concrete mix shall be the same as that required to meet the specified strength class of concrete without the admixture.

A plasticizing admixture shall not be added at the job site.

TABLE 1 – SPECIFICATION LIMITS FOR NONPLASTICIZED AND SUPERPLASTICIZED CONCRETE

<u>Specification Requirement</u>	<u>Nonplasticized Concrete</u>	<u>Plasticized Concrete</u> <u>2/</u>
Slump	1-5 inches	7 ½ inches <u>3/</u>
Free Fall		
Structural Formed Concrete	5 feet	12 feet
Architectural Concrete	3 feet	10 feet
Lift Thickness		
Structural Formed Concrete	20 inches	5 feet <u>1/</u>
Architectural Concrete	20 inches	5 feet <u>1/</u>
Conveying Time/Temp.	90 <u>min@<85F</u> 45 <u>min@>85F</u>	95 F (MAX) @ slump within range specified

1/ Forms must be designed to withstand full hydraulic pressure resulting from the near fluid state of superplasticized concrete often effective for the duration of placement. Tightness of forms is also critical since superplasticized concrete will leak through very small cracks.

2/ The suggested limitations for superplasticized concrete were adapted from specifications developed by the Corps of Engineers for work in the Middle East. The project experiences came off a long learning curve during a 5-year period where great quantities of concrete, with and without supers, were placed by many contractors. See superplasticized Concrete, A Practical Approach by W. Voelker included in Reference No. 18.

3/ If the contractor can demonstrate nonsegregation in the mix performance, a slump of 9 inches maximum may be allowed.

TABLE 2 - TYPICAL SUPERPLASTICIZERS

<u>SUPER TRADE NAME & TYPE</u>	<u>MANUFACTURER</u>	<u>GENERIC CLASS</u>
Alkanol-CA	E.I. Dupont De Nemours And Company	Complex alkylaryl sulfonate
Daracem-100	W.R. Grace and Co.	Sulfonated Naphthalene- Formaldehyde Condensate
Melment L-10	American Admixtures Corporation	Sulfonated melamine- Formaldehyde Condensate
Mighty-150 (Type F)	Boremco Specialty Chemicals	Sulfonated naphthalene- formaldehyde condensates
PSP-N (Type F)	Protex Industries, Incorporated	Modified sulfonated naphthalene- formaldehyde condensates
Sikament 300 (Type F)	Sika Chemical Corporation	sulfonated naphthalene- formaldehyde Condensate
Sikament 320 And Sikament 86 (Type F)	Sike Chemical Corporation	Sulfonated melamine- formaldehyde condensate

WRDA-19 (Type F)	W.R. Grace and Co.	Sulfonated naphthalene- formaldehyde condensate
RHEOBUILD 1000 (Type F)	Master Builders Technologies	Nepthalene
RHEOBUILD 716 (Type G)	Master Builders Technologies	Nepthalene w/Retarder

